

Current Developments in Future Planetary Probe Sensors for TPS

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In-situ Thermal Protection System (TPS) sensors are required to provide traceability of TPS performance and sizing tools. Traceability will lead to higher fidelity design tools, which in turn will lead to lower design safety margins, and decreased heatshield mass. Decreasing TPS mass will enable certain missions that are not otherwise feasible, and directly increase science payload. NASA Ames is currently developing two flight measurements as essential to advancing the state of TPS traceability for material modeling and aerothermal simulation: heat flux and surface recession (for ablators). The heat flux gage is applicable to both ablators and non-ablators and is therefore the more generalized sensor concept of the two with wider applicability to mission scenarios.

This paper describes the development of a microsensor capable of surface and in-depth temperature and heat flux measurements for TPS materials appropriate to Titan, Neptune, and Mars aerocapture, and direct entry. The thermal sensor will be monolithic solid state devices composed of thick film platinum RTD on an alumina substrate. Choice of materials and critical dimensions are used to tailor gage response, determined during calibration activities, to specific (forebody vs. aftbody) heating environments. Current design has maximum operating temperature of 1500K, and allowable constant heat flux of $q=28.7 \text{ W/cm}^2$, and time constants between 0.05 and 0.2 seconds. The catalytic and radiative response of these heat flux gages can also be changed through the use of appropriate coatings. By using several co-located gages with various surface coatings, data can be obtained to isolate surface heat flux components due to radiation, catalycity and convection. Selectivity to radiative heat flux is a useful feature even for an in-depth gage, as radiative transport may be a significant heat transport mechanism for porous TPS materials in Titan aerocapture. This paper also reports on progress to adapt a previously flown surface recession sensor, based on the Jupiter probe Galileo Analog Resistance Ablation Detector (ARAD), to appropriate aerocapture conditions.